Blends of Diesel – used Vegetable Oil in a Four-Stroke Diesel Engine

Charalampos Arapatsakos[1]

Department of Production and Management Engineering, Democritus University of Thrace

V. Sofias Street, 67100, Xanthi, Greece

[1*]xarapat@agro.duth.gr

Abstract

In the days before the proliferation of large cities and industry, nature's own systems kept the air fairly clean. Wind mixed and dispersed the gases, rain washed the dust and other easily dissolved substances to the ground and plants absorbed carbon dioxide and replaced it with oxygen. With increasing urbanization and industrialization humans started to release more wastes into the atmosphere than nature could cope with. Since then, more pollution has been added to the air by industrial, commercial and domestic sources. There are several many types of air pollutant. These include smog, acid rain, the greenhouse effect and holes in the ozone layer. The atmospheric conditions such as the wind, rain, stability affect the transportation of the air pollutant. This paper examines the use of diesel-used vegetable oil mixtures in a four-stroke diesel engine. The mixtures that have been used are the following: diesel-5% used vegetable oil, diesel-10% used vegetable oil, diesel-20% used vegetable oil, diesel-30% used vegetable oil, diesel-40% used vegetable oil, diesel-50% used vegetable oil. For those mixtures the gas emissions of carbon monoxide (CO), hydrocarbons (HC), nitrogen monoxide (NO), smoke are being measured. Also the gas emissions temperatures are being measured and the consumption for any fuel mixture is examined. The fuel temperatures were 30°C and 40°C.

Keywords

Gas Emissions; Vegetable Oil; Biofuels; Fuel Temperature

Introduction

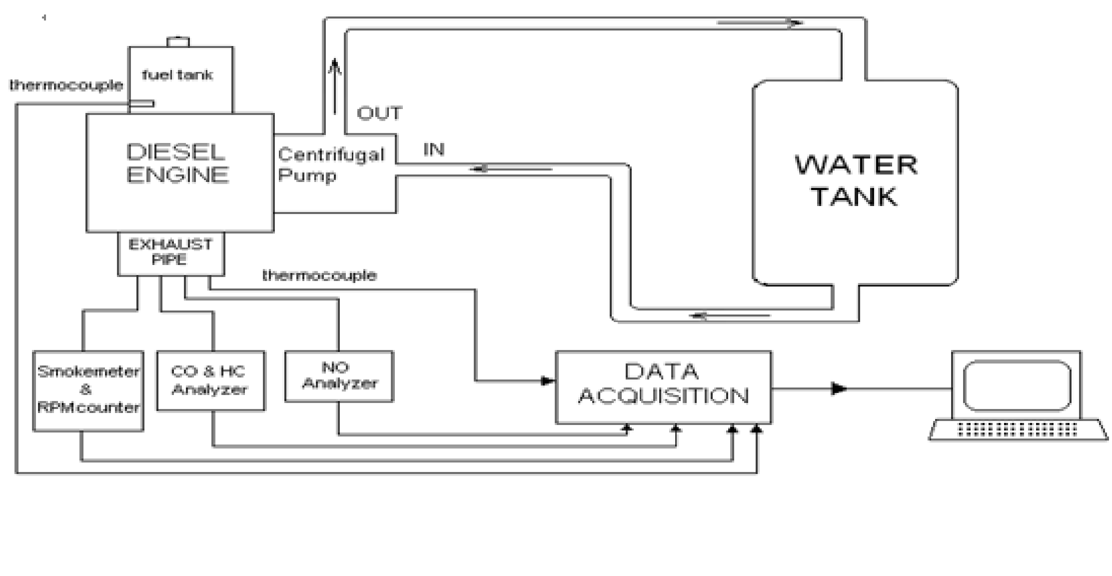
Air pollution is one of the most serious environmental problems confronting our civilization today. Air pollution is the presence of toxic chemicals or compounds in the air. These compounds may be found into the air in two major forms, in a gaseous and in a solid form. The most common causes of air pollution are various human activities, including industry, construction, transport agriculture etc. However, there are some natural processes such as volcanic eruptions and wildfires too [1, 2, 3]. The effects of air pollution vary from simply coughing or skin problems to serious diseases, such as cancer, chronic respiratory disease, heart disease etc. People of all ages can be affected from air pollution and particularly from sources such as vehicle exhausts and residential heating, but mainly those with existing heart and respiratory problems are in an extra risk. Air pollutants are also responsible for the acidification of forests and water ecosystems and eutrophication of soils and waters and corrode buildings and materials [4, 5, 6]. One of the main causes of air pollution is transportation and particularly the increased emissions from the road traffic. In order to improve air quality scientists are focusing in the use of alternative fuels that can give energy without harming the environment. Biomass offers a physical way to produce energy without damaging the environment. Biofuels are alcohols, ethers, esters, and other chemicals made from cellulosic biomass such as herbaceous and woody plants, agricultural and forestry residues, and a large portion of municipal solid and industrial waste. The term biofuels can refer to fuels for electricity and fuels for transportation. Unlike petroleum, which is a non-renewable natural resource, biofuels are renewable and inexhaustible source of fuel. Biofuel is used to produce power, heat and steam and fuel through a number of different processes. Consequently, it can be used to power vehicles, heat homes and for cooking. Vegetable oil is an alternative renewable fuel for diesel engines [7, 8, 9]. There are two main types of vegetable oil fuels, the straight vegetable oil and the waste vegetable oil. Straight vegetable oil is the relatively unprocessed or unadulterated oil pressed from a variety of vegetables

and plants. These oils can be used for cooking and power vehicles too. Some examples of vegetable oil are palm oil, cottonseed oil and corn oil. Waste vegetable oil is the oil that has already been used for cooking and can no longer be used for that purpose. Both types of oil can be used just as they are or they can be mixed with diesel fuel in engines modified to use them. The use of vegetable oils has many benefits. First of all it is better for your engine as it provides additional lubrication and reduces engine deposits. It is less likely to cause a fire or explosion in the case of an accident. It also results in lower emissions, as the carbon dioxide produced by burning vegetable oil is less than the amount absorbed by the plants from which the oil is obtained, vehicles running on vegetable oil produce no net increase in atmospheric carbon dioxide. Finally, vegetable oil fuel is indefinitely renewable. However, in order to use vegetable oil either straight or waste, it requires engine modification, which is inconvenient and expensive [10].

The major issue is how a four-stroke diesel engine behaves on the side of pollutants and operation, when it uses directly mixed fuel of diesel – used vegetable oil [11].

Instrumentation and Experimental Results

In the experiment stage has been used directly used vegetable oil (used sunflower oil that emanated from cooking) in the mixture of diesel in to a four – stroke diesel engine. Specifically it has been used diesel, mixture diesel-5% used vegetable oil (tig5), diesel-10 used vegetable oil (tig10), diesel-20% used vegetable oil (tig20), diesel-30% used vegetable oil (tig30), diesel-40% used vegetable oil (tig40), diesel-50% used vegetable oil (tig50) in a four-stroke diesel air-cooled engine named Ruggerini type RD-80, volume 377cc, and power 8.2hp/3000rpm, who was connected with a pump of water centrifugal. Measurements were made when the engine was functioned on 1000, 1500, 2000 and 2500rpm. The fuel temperatures were firstly 30^{o}C and secondly 40^{o}C. During the experiments, it has been counted: The percent of CO, the ppm of HC, the ppm of NO, the percent of smoke, the gas emissions temperature and the fuel consumption. The measurement of rounds/min of the engine was made by a portable tachometer (Digital photo/contact tachometer) named LTLutron DT-2236. Smoke was measured by a specifically measurement device named SMOKE MODULE EXHAUST GAS ANALYSER MOD 9010/M, which it has been connected to a PC unit. The CO and HC emissions have been measured by HORIBA Analyzer MEXA-324 GE. The NO emissions have been measured by a Single GAS Analyser SGA92-NO. The experimental results are shown at the following figures:



PIC. 1 EXPERIMENTAL LAYOUT

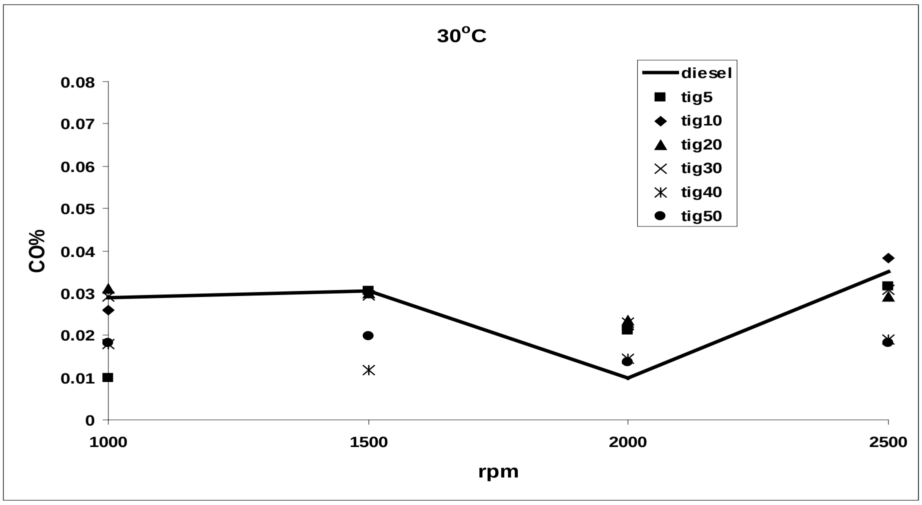


FIG. 1 THE CO VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 30°C

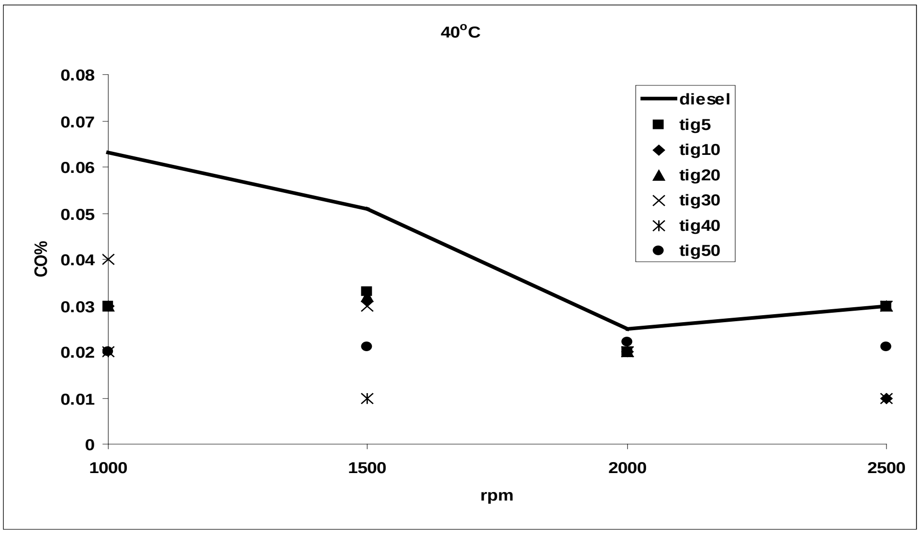


FIG. 2 THE CO VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 40°C

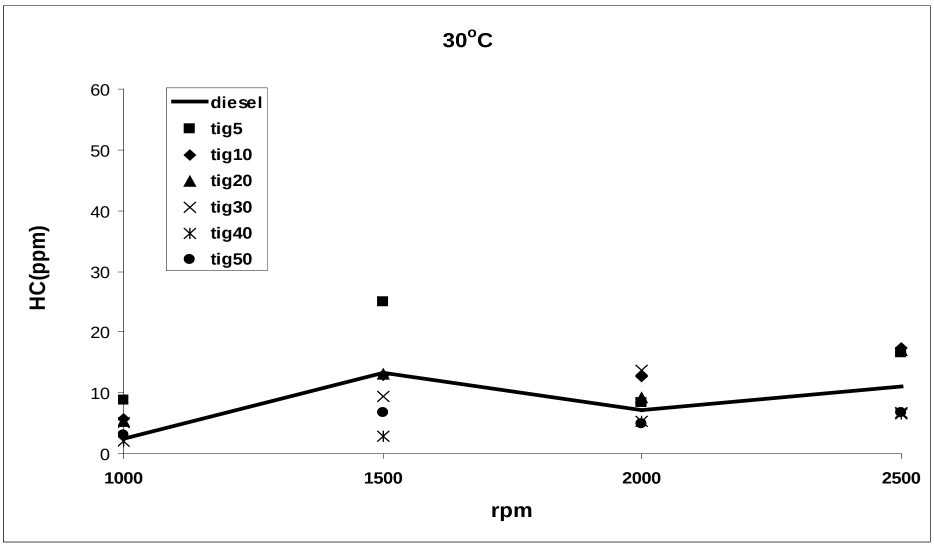


FIG. 3 THE HC VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 30°C

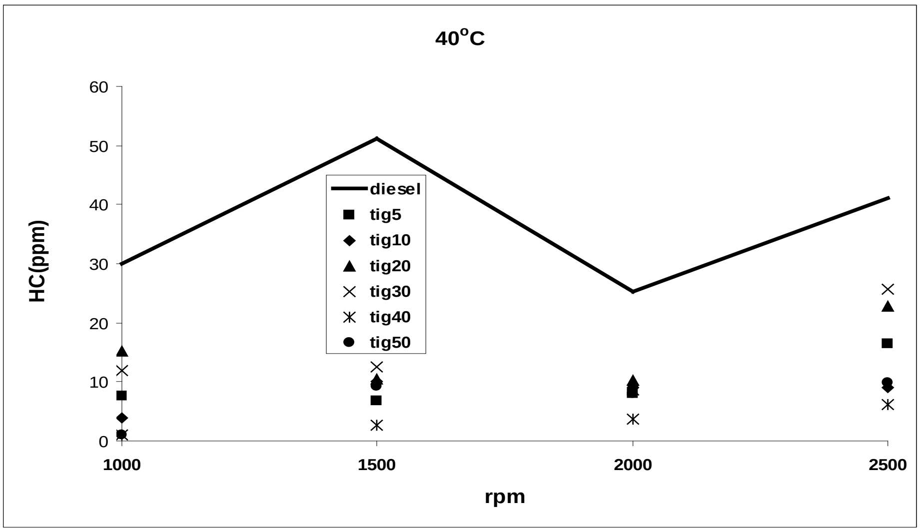


FIG. 4 THE HC VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 40°C

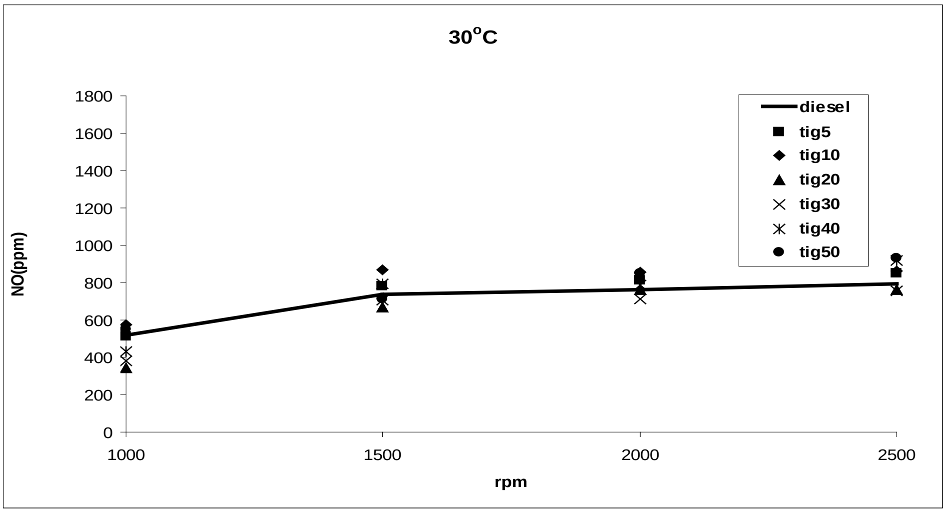


FIG. 5 THE NO VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 30°C

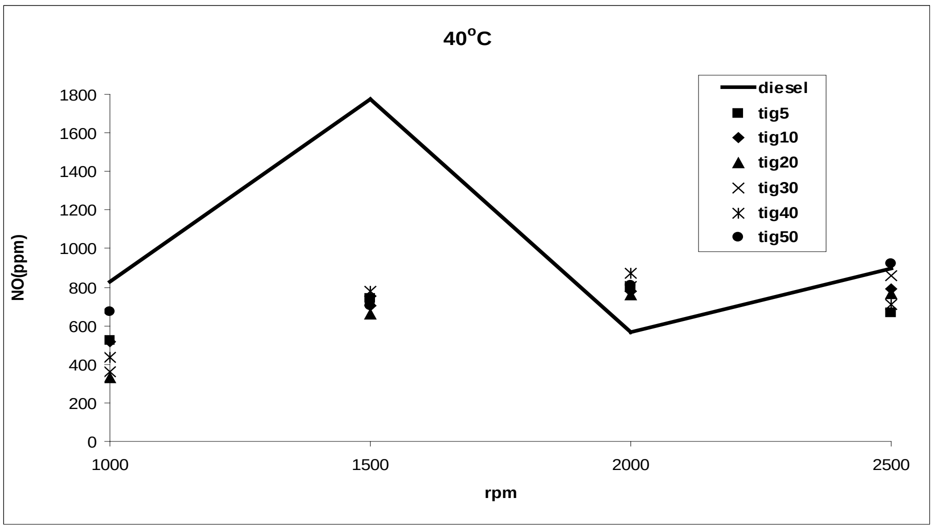


FIG. 6 THE NO VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 40°C

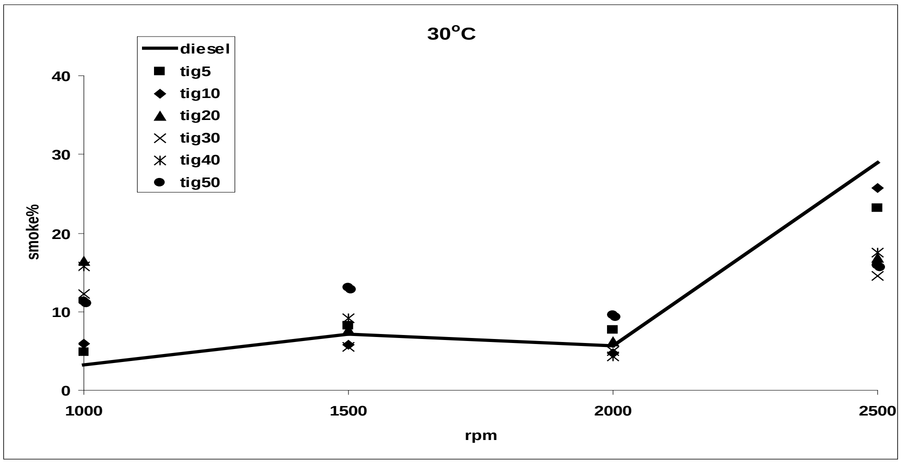


FIG. 7 THE SMOKE VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 30°C

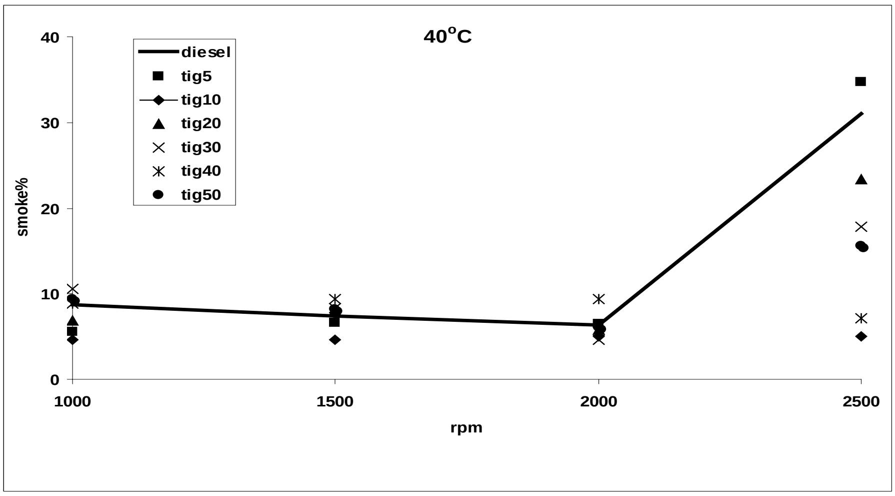


FIG. 8 THE SMOKE VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE, WHEN THE FUEL TEMPERATURE IS 40°C

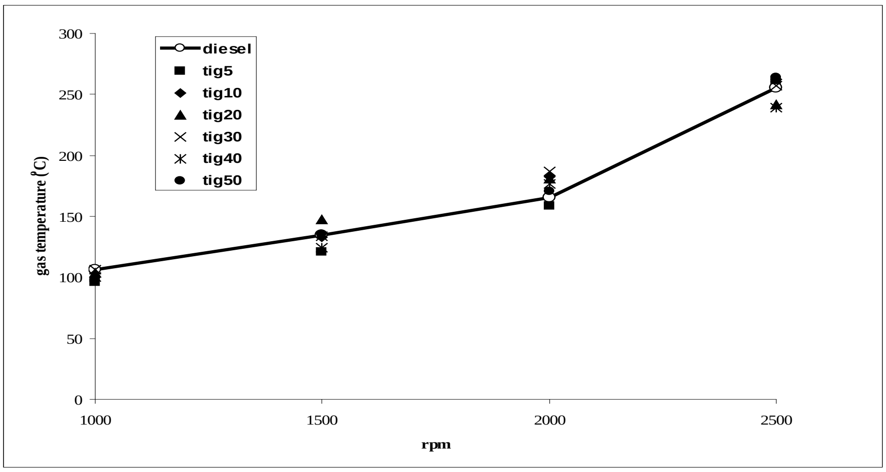


FIG. 9 THE GAS TEMPERATURE VARIATION ON DIFFERENT ENGINE RPM REGARDING TO THE MIXTURE

In the case of 30°C as fuel temperature:

From figure 1 it can be noticed that the most constant behaviour appeared in the mixture of tig40, while the best behaviour appeared in the case of diesel at 1500rpm.

From figure 3 it can be noticed that the biggest reduction of HC emissions regarded to diesel presented in the mixture of tig 40. Figure 5 show that

the biggest reduction of NO emissions regarding to diesel appeared in the mixture of tig40. Finally, from figure 7 it can be said that the biggest reduction of smoke emissions regarding to diesel appeared in the mixtures of tig30 and tig40.

In the case of 40°C as fuel temperature:

From figure 2 it is clear that mixtures tig5, tig10, tig20, tig30, tig40 and tig50 presented lower CO emissions regarding to diesel. From figure 4, it can be seen a reduction of HC emissions when using different mixtures than diesel. In figure 6 it is also presented a reduction of NO emissions regarding to diesel with the exception of the engine functioned on 2000 rpm, in where the diesel presented lower NO emissions than the mixtures. Finally, from figure 8, it can be seen that mixtures tig10, tig20, tig30, and tig50 presented lower smoke emissions than diesel. However, when the engine functioned on 1000, 1500 and 2000 rpm, the mixture tig40 presented higher smoke emissions than diesel. On the other hand, the mixture tig5 presented lower smoke emissions than diesel with the exception of the engine functioned on 2500 rpm, in where the smoke emissions were higher than diesel.

From the above figures it can be concluded that the use of different mixtures can constitute changes to CO, HC, and NO and smoke too. It is also important to mention that there were no changes in the rounds of the engine, as well as in the supply of water during the use of mixtures. As far as the gas emissions temperature (fig. 9) and the fuel consumption is concerned, did not observed any changes with the use of different mixtures on the different fuel temperatures.

Conclusion

The use of mixtures diesel-used vegetable oil has as result the gas emissions variation. Better behaviour presented in the mixtures of tig30 and tig40. The density and viscosity of those mixtures did not create any problems in the spraying of fuel. As it has already been mentioned above the different fuel temperatures (30°C, 40°C) differentiate the gas emissions.

It is also important to mention, that during the combustion of the mixtures there was not presented any reduction in the power of the engine.

Finally, it has not been presented engine malfunction from the directly use of fuel mixtures diesel - used vegetable oil.

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